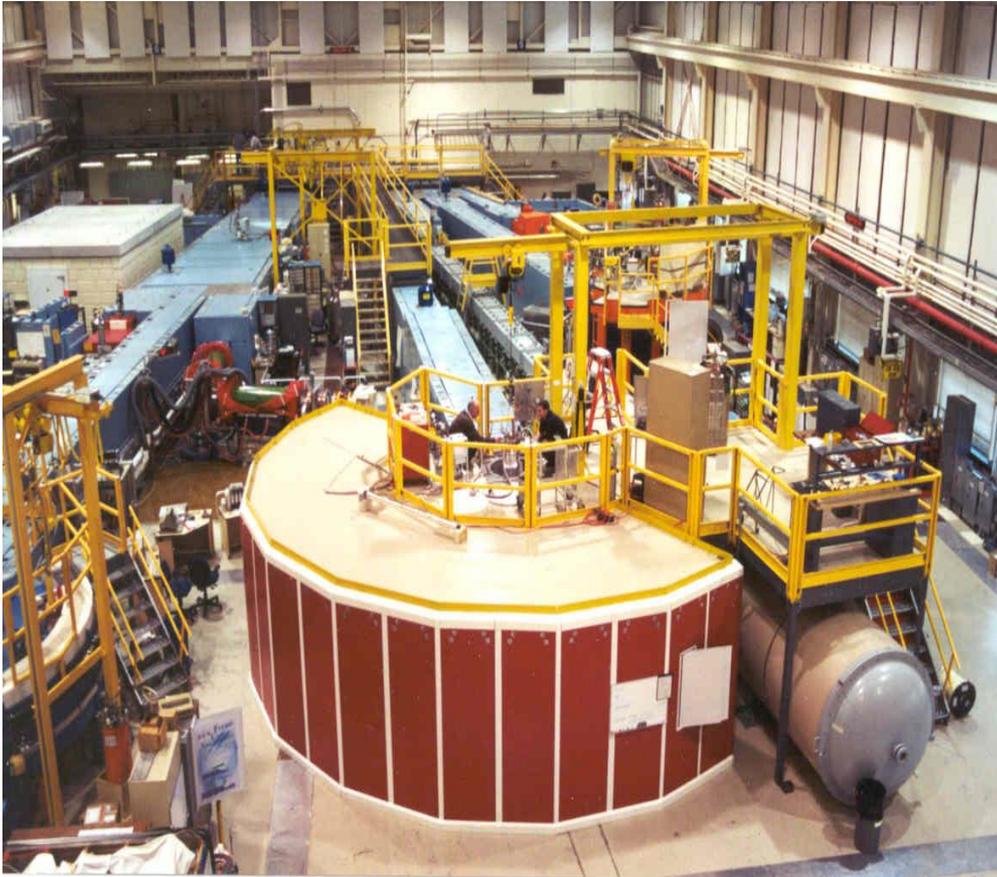
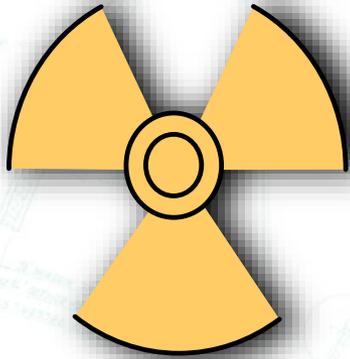


Radiation Safety – Health Physics

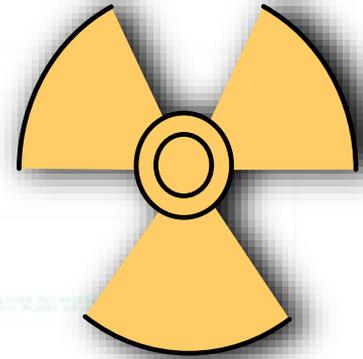


Neutron Scattering Summer School 2015

Thomas P. Johnston, NCNR Health Physics

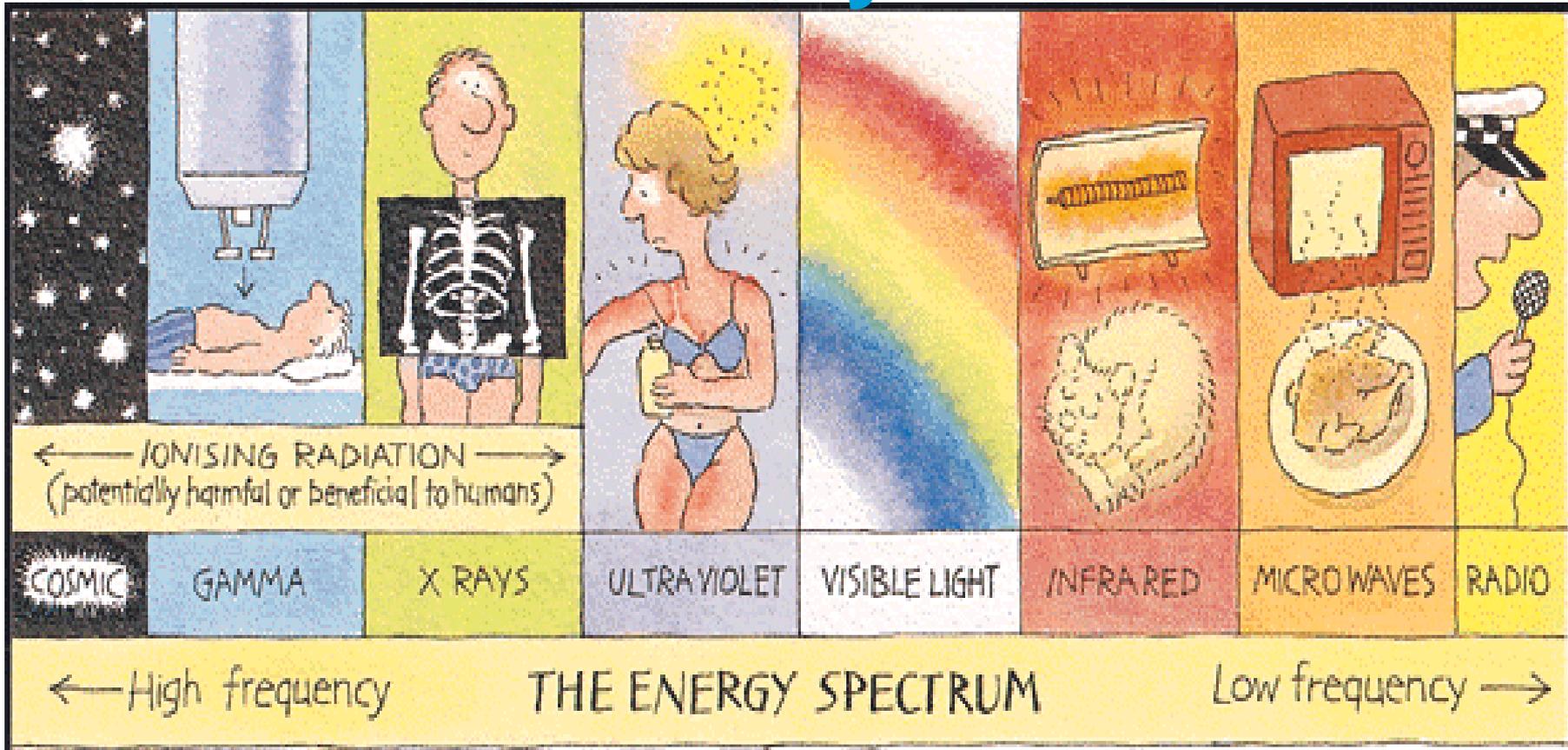


Training Outline



- **Radiation, Ionization and Radioactivity**
- **Radiation Dose**
- **Radiation Safety**
- **Questions: x5810, x5815**

Electromagnetic Radiation: Gammas and X-Rays



THE ELECTROMAGNETIC SPECTRUM

Radiation Basics

What is Radiation?

Radiation

- Energy moving through space as invisible waves

Non-ionizing Radiation

- Light, sound, heat or infrared waves, microwaves, radio waves, low frequency power line radiation

Ionizing Radiation



Alpha particles
(Fast moving helium nucleus)



Beta particles
(Fast moving electron)

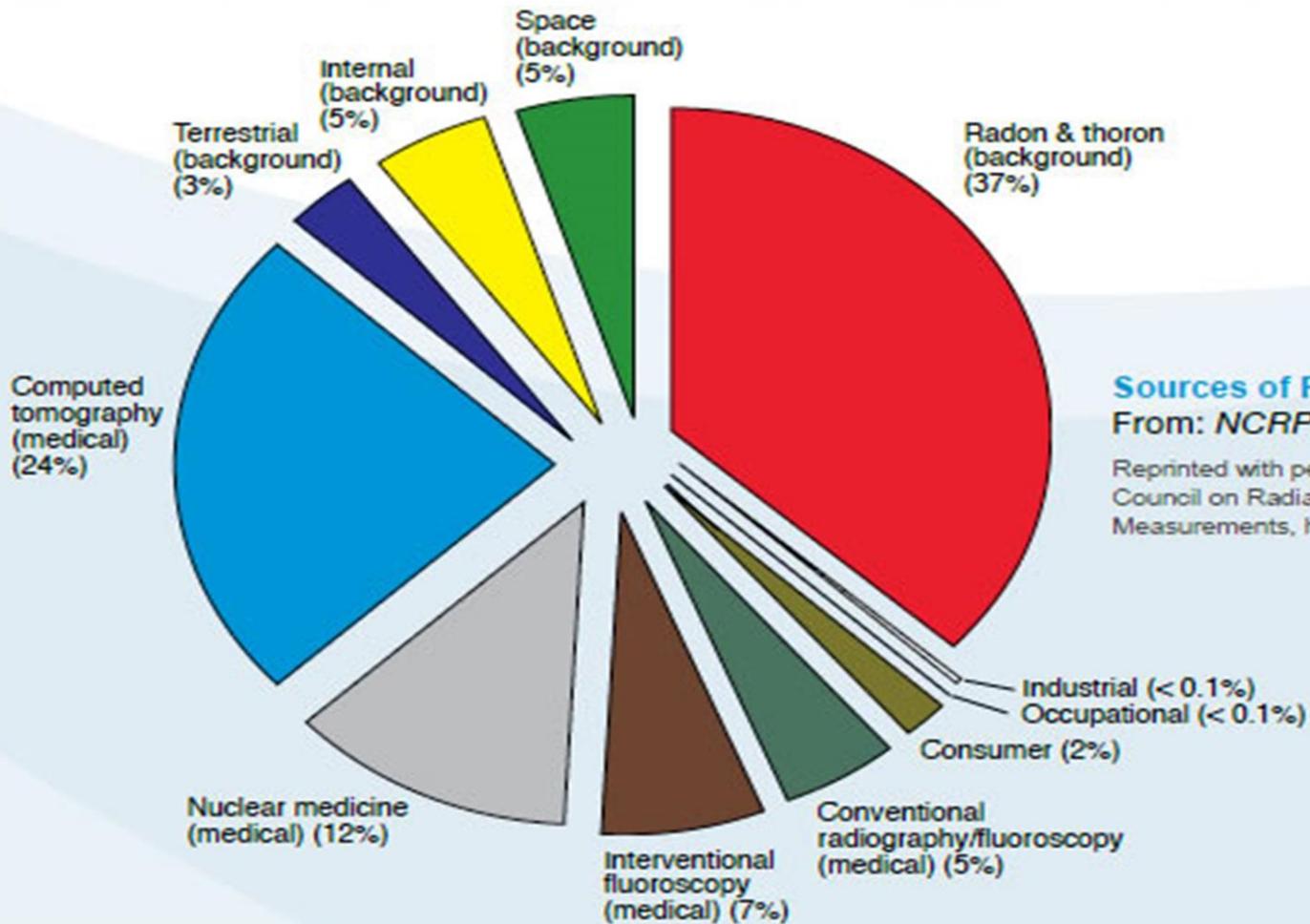
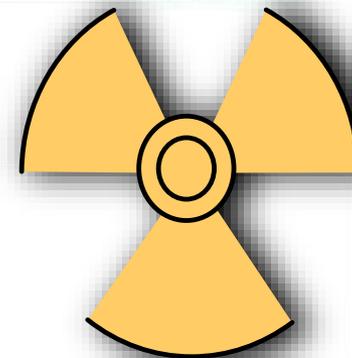


Neutrons



Gamma, X-ray

Background Radiation



Sources of Radiation Exposure
From: *NCRP Report No. 160*

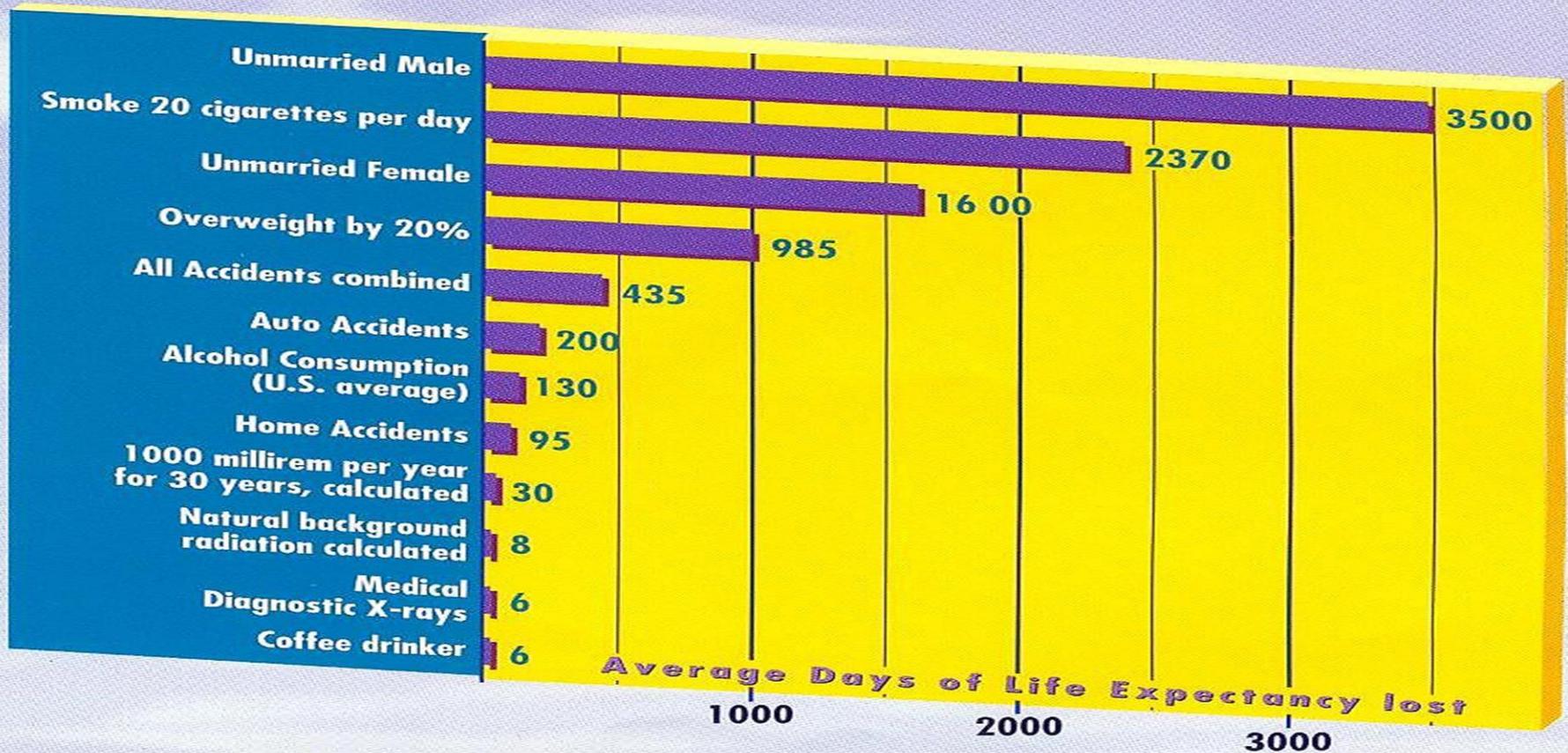
Reprinted with permission of the National Council on Radiation Protection and Measurements, <http://NCRPonline.org>

US Average ~ 620 mrem/y

For Comparison

Health Risks from Radiation Compared with Other Situations

Estimated Loss of Life Expectancy

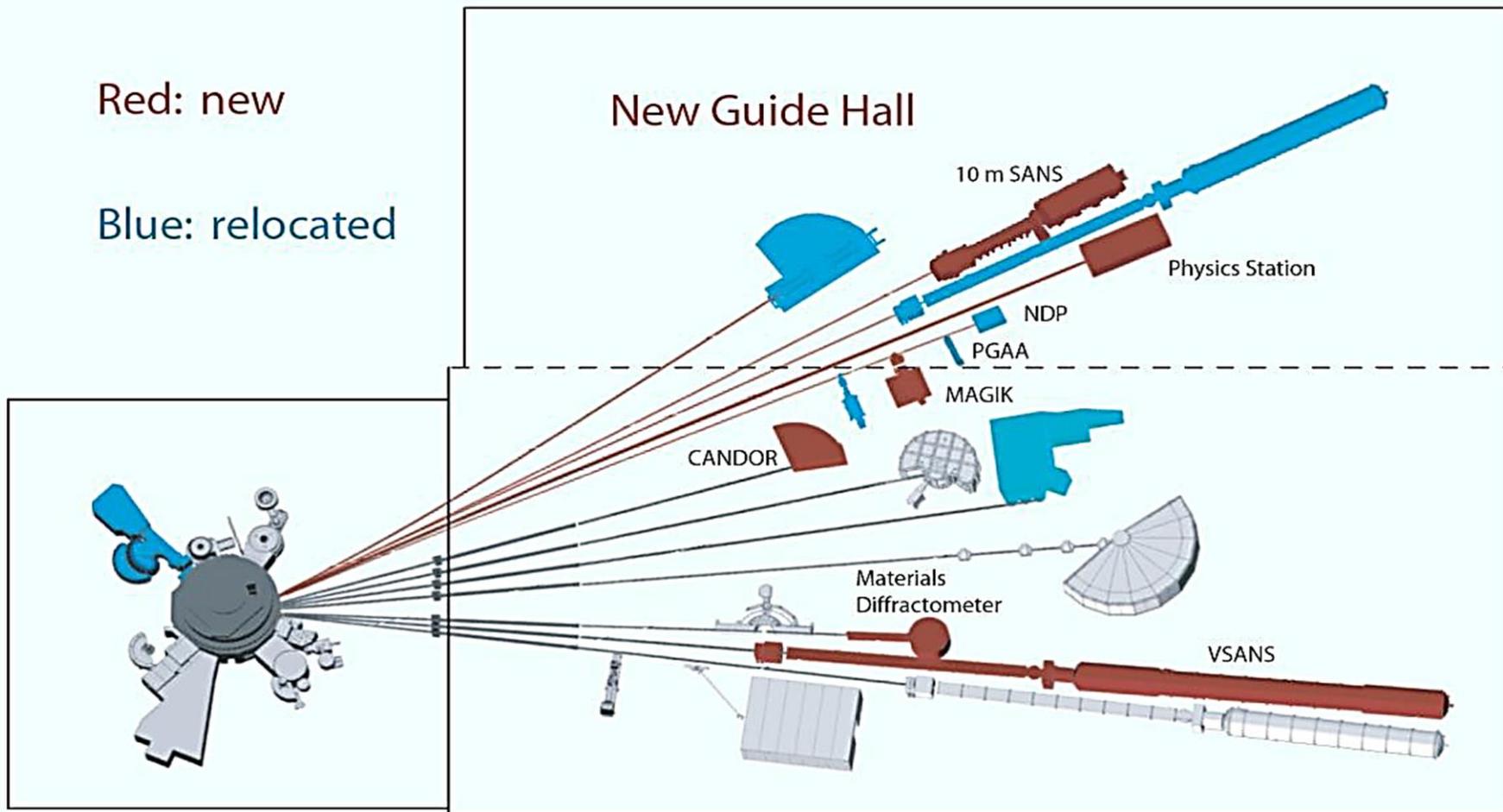


The NCNR Layout

Red: new

Blue: relocated

New Guide Hall

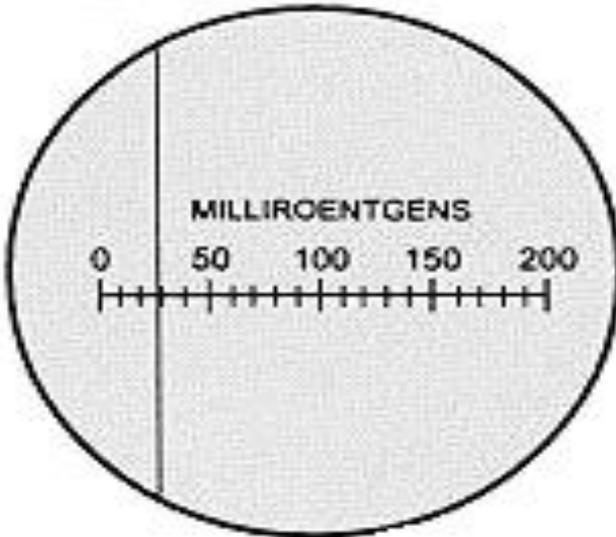


Radiation Dosimetry



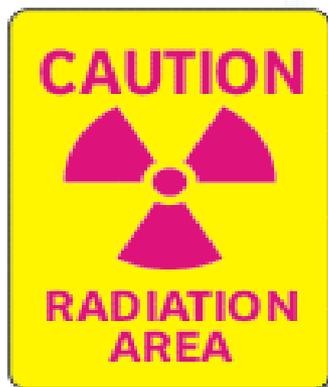
**Occupational Dose
Limit = 5,000 mrem/y**

**General Public Dose Limit
= 100 mrem/y
Average Dose to US Public
= 620 mrem/y**

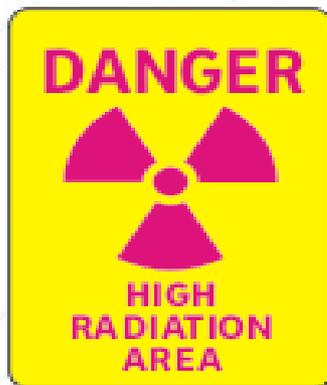


**Average Dose to NIST
Researcher ~ 50 mrem/y**

Health Physics Labels/Signs



**>5 mrem/h
(whole body
dose rate)**



**>100 mrem/h
(whole body
dose rate)**



**~100,000 mrem/h
(localized dose rate)**

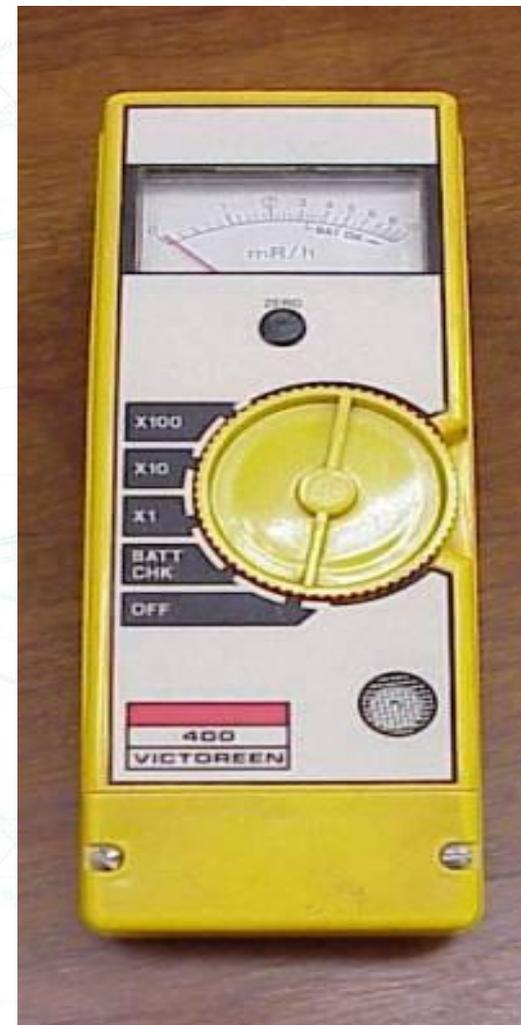
Contamination Control



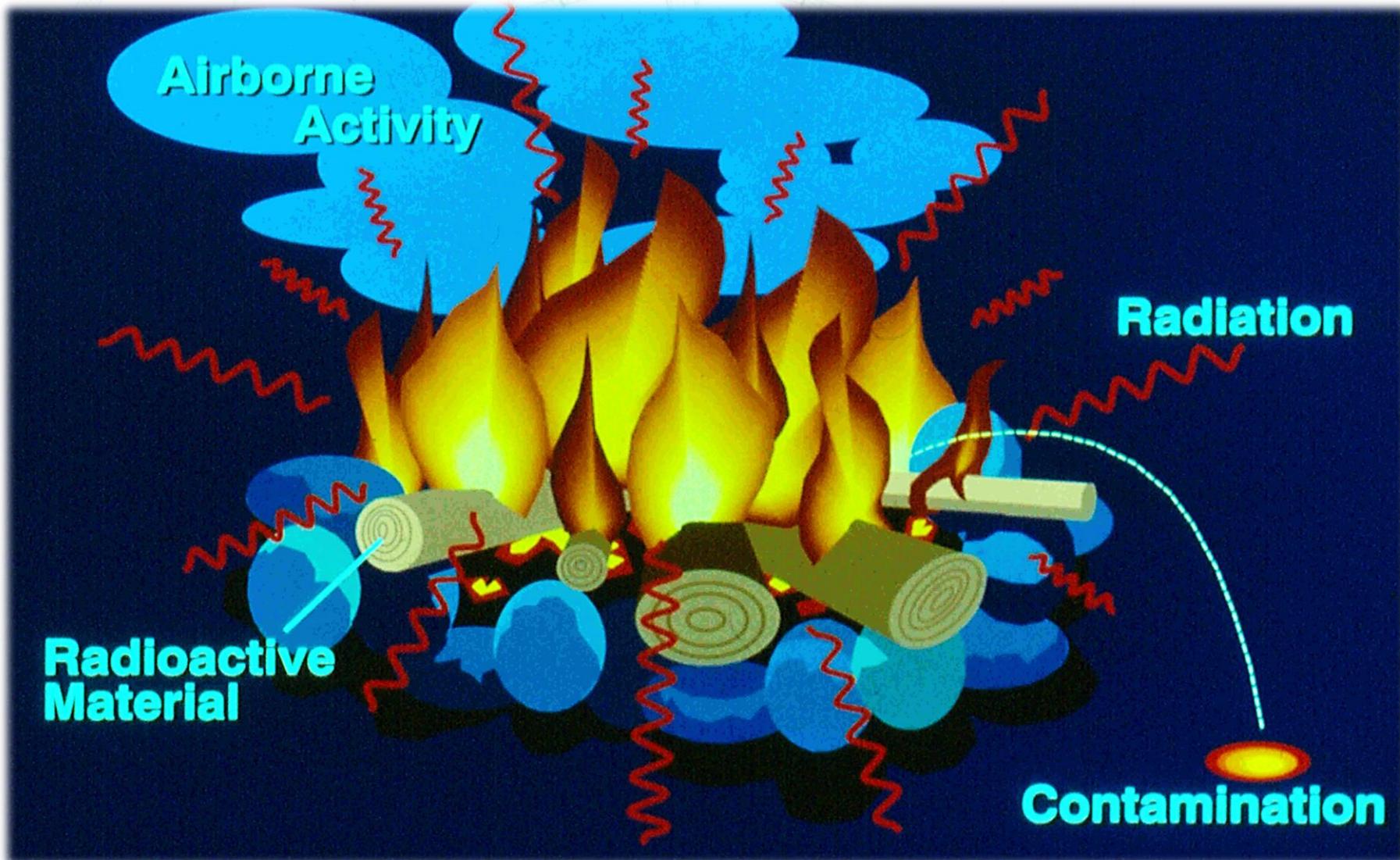
Always monitor yourself and items you have with you when leaving a controlled area.



Radiation Detection / Measurement



Campfire Analogy

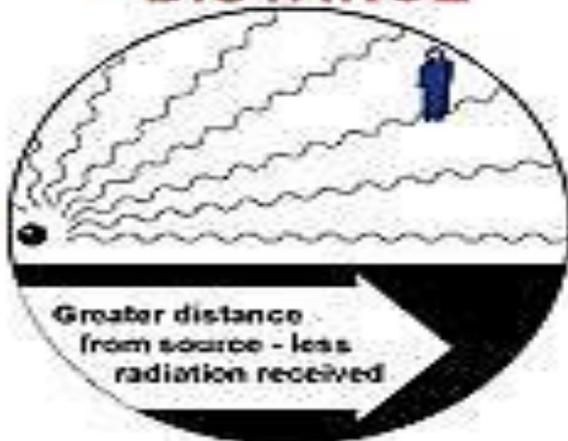


Time, Distance, and Shielding

TIME



DISTANCE



SHIELDING



Time, Distance, Shielding...

Time	Reduce the duration of exposure
Distance	Increase distance between and the source
Shielding	Place shielding between personnel and the source



Shielding Formula

$$I = I_0 e^{-\mu x}$$

- I = Radiation intensity after shielding
- I_0 = Radiation intensity before shielding
- e = logarithm base e (2.178)
- μ = linear attenuation coefficient
- x = thickness of shielding material in centimeter(s)

Ionizing Radiation

Can not see it, feel it, or smell it

Relatively simple to detect and measure

Biological effects have been intensely studied for 50 years

Questions? x5810, x5815

